An Original Study

Does Preoperative Pneumonia Affect Complications of Geriatric Hip Fracture Surgery?

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Abstract

Preoperative pneumonia, reported in 0.3% to 3.2% of hip fracture patients, may be a risk factor for adverse outcomes of hip fracture repair. No studies have reported on baseline differences or adverse outcomes in surgically managed geriatric hip fracture patients with and without preoperative pneumonia, and no data argue for or against delaying surgery in these patients.

A retrospective cohort of geriatric patients with operatively treated hip fractures from 2005 to 2012 was identified in the National Surgical Quality Improvement Program database. Preoperative pneumonia was present in 82 (1.2%) of 7128 geriatric hip fracture patients identified and was associated with male sex, transfer status, functional status, preoperative anemia, confusion, dyspnea at rest, and chronic obstructive pulmonary disease. Multivariate analysis of 30-day outcomes of hip fracture repair revealed that preoperative pneumonia was associated with a higher risk for any adverse event (relative risk [RR] = 1.44), serious adverse event (RR = 1.79), and death (RR = 2.08) after hip fracture repair. Underweight body mass index at time of surgery (<18.5 kg/m^2) was predictive of 30-day mortality (RR = 4.67). Surgical delay of 1 to 4 days was not associated with adverse events.

Geriatric hip fracture patients with preoperative pneumonia, especially the underweight, are at increased risk for complications and death after hip fracture repair. We cannot recommend against early hip fracture surgery in this population.

P reoperative pneumonia remains relatively unexplored as a risk factor for adverse outcomes in geriatric hip fracture surgery. Dated studies report a 0.3% to 3.2% prevalence of "recent pneumonia" in patients presenting with hip fracture but provide neither a definition of pneumonia based on clinical criteria nor a subset analysis of outcomes in the pneumonia group.[1-3] Although active pneumonia has been identified as a preoperative optimization target in the management guidelines for geriatric hip fracture,[4] we are unaware of any studies that have reported on differences in demographics, comorbidities, delay to surgery, or adverse outcomes between hip fracture patients with and without preoperative pneumonia.

This paucity of information on the effect of preoperative pneumonia in the hip fracture population may be related to low prevalence of preoperative pneumonia and a cadre of variable definitions, which limit identification of a cohort of patients with preoperative pneumonia large enough from which to draw meaningful results. Database studies, especially those using surgical registries rather than administrative or reimbursement data, offer particular advantages for investigation of such rare clinical entities.[5]

Medical care of patients with pneumonia alone is known to be facilitated by assessments of mortality risk from clinical and laboratory data. The modified British Thoracic Society rule/CURB-65 (confusion, urea, respiratory rate, blood pressure)

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score is strongly predictive of mortality in hospitalized adults with pneumonia (odds ratio [OR], 4.59; 95% confidence interval [CI], 1.42-14.85; P = .011) and may guide antibiotic therapy, laboratory investigations, and the decision to intubate in a patient with pneumonia.[6-8] This score is predictive of adverse events (AEs), hospital length of stay, and use of intensive care services.[6,7,9-13] We hypothesized that preoperative clinical indicators assessed by pneumonia severity scores as well as patient demographics and baseline comorbidities may also have prognostic value for risk of AEs in a cohort of geriatric hip fracture surgery patients with preoperative pneumonia.

In this article, we first describe the prevalence of preoperative pneumonia in geriatric hip fracture surgery patients as well as demographic and operative differences between patients with and without the disease. We then ask 3 questions: Is preoperative pneumonia an independent risk factor for mortality and adverse outcomes in geriatric hip fracture surgery? Is there a postoperative interval during which the unadjusted mortality rate is higher among patients with preoperative pneumonia? In patients with preoperative pneumonia, what are the predictors of morbidity and mortality?

Methods

Yale University's Human Investigations Committee approved this retrospective cohort study, which used the American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) database for the period 2005 to 2012. ACS-NSQIP is a prospective, multi-institutional outcomes program that collects data on preoperative comorbidities, intraoperative variables, and 30-day postoperative outcomes for patients undergoing surgical procedures in inpatient and outpatient settings.[14]

Unlike administrative databases, which are based on reimbursement data, ACS-NSQIP data are collected by trained surgical clinical review-

ers for the purposes of quality improvement and clinical research, and data quality is ensured with routine auditing.[15] The program has gained a high degree of respect as a powerful and valid data source in both general[16] and orthopedic[17] surgery literature. The database offers a particular advantage with respect to the study of preoperative pneumonia: Only patients with new or recently diagnosed pneumonia on antibiotic therapy who meet strict criteria for characteristic findings on chest radiography, clinical signs and symptoms of respiratory illness, and positive cultures are coded as having actively treated pneumonia at time of surgery.[15]

To identify hip fracture patients over the age of 65 years who underwent operative fixation of a hip fracture, we used *Current Procedural Terminology* (*CPT*) hip fracture codes, including 27235 (percutaneous screw fixation), 27236 or 27244 (plate-and-screw fixation), and 27245 (intramedullary device), as well as 27125 (hemiarthroplasty) and 27130 (arthroplasty) for patients with a postoperative *International Classification of Disease, Ninth Revision* (*ICD-9*) diagnosis code (820.x, 820.2x, or 820.8) consistent with acute hip fracture.[18,19] Procedure type, anesthesia type, and delay from admission to surgery were captured for all procedures.

Preoperative demographics included age, sex, transfer origin, functional status, and body mass index (BMI) category. Binary comorbidities were classified as preoperative anemia (hematocrit, <0.41 for men, <0.36 for women), confusion, dyspnea at rest, uremia (blood urea nitrogen, >6.8 mmol/L), history of cardiovascular disease (congestive heart failure, myocardial infarction, percutaneous coronary intervention, angina pectoris, medically treated hypertension, peripheral vascular disease, or resting claudication), chronic obstructive pulmonary disease, diabetes, renal disease (renal failure or dialysis), and cigarette use in preceding 12 months.[20,21] Although preoperative hypotension and respiratory rate are often considered in patients with pneumonia, these variables were not available from the ACS-NSQIP data.[6,22]

Pearson χ^2 test for categorical variables was used to compare baseline demographics and operative characteristics between patients with and without pneumonia, and Student t test was used to compare intervals from hospital admission to hip fracture surgery, surgery start to surgery stop, and surgery to discharge between patients with and without preoperative pneumonia.

Binary outcome measures were compared

between patients with and without preoperative pneumonia. "Any AE" included any serious AE (SAE) or any minor AE. SAEs included death, acute renal failure, ventilator use >48 hours, unplanned intubation, septic shock, sepsis, return to operating room, coma >24 hours, cardiac arrest requiring cardiopulmonary resuscitation, myocardial infarction, thromboembolic event (deep vein thrombosis or pulmonary embolism), and stroke/cerebrovascular accident. Minor AEs included progressive renal insufficiency, urinary tract infection, organ/space infection, superficial surgical-site infection, deep surgical-site infection, and wound dehiscence. Other binary outcome measures included discharge destination and unplanned readmission within 30 days after hip fracture surgery.[23]

Poisson regression with robust error variance as described by Zou[24] was used to compare the rates of any, minor, and individual AEs, and any SAEs, between patients with and without pneumonia. Multivariate analysis accounted for the baseline variables in **Table 1**. AEs that occurred more than once in each group were included in the analyses.

Kaplan-Meier survival analysis was performed for postoperative mortality within 30 days. Within the preoperative pneumonia group, covariates from Table 1 were identified as predictors of any AE, SAE, or death within 30 days after hip fracture surgery by stepwise multivariate Poisson regression with robust error variance. When interval from admission to surgery was longer than 24, 48, 72, or 96 hours, it was also included as a covariate. Variables that did not show an association with AEs at the $P < .20$ level were not included in the final regression model. All analyses were performed with Stata/SE Version 12.0 statistical software (StataCorp).

Results

Of the 7128 geriatric hip fracture patients in this study, 82 (1.2%) had active pneumonia at time of surgery (Table 1). Age, BMI, preoperative uremia, history of cardiovascular disease, diabetes, renal disease, and smoking were similar between groups. In addition, there was no difference in anesthesia type or fixation procedure between the pneumonia and no-pneumonia groups. Patients with preoperative pneumonia differed significantly with respect to sex, transfer from facility, preoperative functional dependence, anemia, confusion, dyspnea at rest, and history of chronic obstructive pulmonary disease (Table 1).

Interval from admission to surgery was longer ($P < .001$) for geriatric hip fracture patients with preoperative pneumonia (mean, 6.8 days; 95% CI, 2.5-11.1 days) than for those without pneumonia (mean, 1.5 days; CI, 1.4-1.5 days). There was no difference ($P = .124$) in operative time between the pneumonia group (mean, 72.8 min; CI, 64.0-81.5 min) and the no-pneumonia group (mean, 66.1 min; CI, 61.2-67.0 min). Interval from surgery to discharge was longer ($P < .001$) for patients with preoperative pneumonia (mean, 10.1 days; CI, 6.9-13.4 days) than for those without pneumonia (mean, 6.3 days; CI, 6.1-6.4 days).

Adverse outcomes of geriatric hip fracture surgery are listed in **Table 2**. In the multivariate analysis, preoperative pneumonia was significantly associated with any AE (relative risk [RR] = 1.44) and any SAE (RR = 1.79). Specific AEs were also assessed. In terms of SAEs, patients with pneumonia were more likely to die (RR = 2.08), develop acute renal failure (RR = 14.61), become comatose for more than 24 hours (RR = 7.31), and require mechanical ventilation for more than 48 hours after surgery (RR = 6.48). In terms of minor AEs, there were no significant differences between patients with and without pneumonia.

Survival patterns diverged between patients with and without preoperative pneumonia (**Figure**). The unadjusted mortality rate was qualitatively higher in patients with preoperative pneumonia than in patients without pneumonia during the first days after hip fracture (slopes of unadjusted mortality curves in Figure). Of note, no patient under age 75 years with pneumonia at time of surgery died within the 30-day study period.

Among geriatric hip fracture patients with preoperative pneumonia, multivariate analyses revealed no significant association of any preoperative comorbidity with any AE or any SAE. Given the gravity of the death complication, however, death within 30 days after surgery was analyzed separately, and was found to be significantly associated (RR = 4.67) with being underweight (BMI, <18.5 kg/m^2) (**Table 3**). Admission-to-surgery interval longer than 24, 48, 72, or 96 hours did not reach significance at the $P < 0.2$ level in the stepwise regressions and therefore was not associated with a higher or lower risk of any AE, SAE, or death.

Discussion

In the general US population, pneumonia accounts for 1.4% of deaths in people 65 years to 74 years old, 2.1% in people 75 years to 84 years, and 3.1% in people 85 years or older. In total, 3.4% of

Table 1. Demographics, Comorbidities, and Operative Parameters of Geriatric Hip Fracture Surgery Patients

	No Pneumonia (n = 7046)		Pneumonia (n = 82)		
	n	%	n	%	*P*
Preoperative patient characteristic					
Age, y					.150
65-74	1153	16.4	8	9.8	
75-84	2508	35.6	36	43.9	
≥85	3385	48.0	38	16.3	
Male sex	1915	27.2	41	50.0	<.001
Transferred from facility	1932	27.4	36	43.9	.001
Functional dependence	3244	46.0	58	70.7	<.001
Body mass index, kg/m^2					.388
<18.5	575	8.2	9	11.0	
18.5-24.9	2952	41.9	41	50.0	
25-29.9	1672	23.7	14	17.1	
30-39.9	719	10.2	7	8.5	
≥40	1128	16.0	11	13.4	
Anemia (hematocrit, <0.41 for men; <0.36 for women)	4324	61.4	66	80.5	<.001
Confusion	205	2.9	10	12.2	<.001
Dyspnea at rest	161	2.3	15	18.3	<.001
Uremia (blood urea nitrogen, >6.8 mmol/L)	3654	51.9	51	62.2	.063
History of:					
Cardiovascular disease[a]	5353	76.0	61	74.4	.739
Chronic obstructive pulmonary disease	854	12.1	29	35.4	<.001
Diabetes	1248	17.7	13	15.9	.661
Renal disease (renal failure or dialysis)	175	2.5	3	3.7	.498
Smoking	615	8.7	7	8.5	.951
Treatment characteristic					
Anesthesia type					.122
General	5089	71.6	52	63.4	
Spinal	1877	26.3	26	31.7	
Other	156	1.2	4	4.9	
Procedure type					.227
Plate/screw fixation	3057	43.4	40	48.8	
Intramedullary implant	1896	26.9	19	23.2	
Hemiarthroplasty	1263	17.9	19	23.2	
Percutaneous fixation	534	7.6	2	2.4	
Total hip arthroplasty	296	4.2	2	2.4	

[a]Congestive heart failure, myocardial infarction, percutaneous coronary intervention, cardiac surgery, angina pectoris, medically treated hypertension, peripheral vascular disease, or resting claudication.

hospital inpatient deaths are attributed to pneumonia.[25] In hospitalized general orthopedic surgical patients as well as hip fracture patients, pneumonia is strongly associated with increased mortality.[26,27]

We identified a preoperative pneumonia prevalence of 1.2%, which is comparable to the rates reported in the literature (0.3%-3.2%).[1-3] To our knowledge, our study represents the largest series

Table 2. **Adverse Outcomes of Hip Fracture Surgery in Geriatric Patients**

Characteristic	No Pneumonia (n = 7046)		Pneumonia (n = 82)		Bivariate Analysis			Multivariate Analysis[a]		
	n	%	n	%	RR	95% CI	P	RR	95% CI	P
Any AE	2612	37.1	49	59.8	1.61	1.35-1.93	<.001	1.44	1.20-1.74	**<.001**
Any SAE	985	14.0	29	35.4	2.53	1.87-3.41	<.001	1.79	1.33-2.44	**<.001**
Death	445	6.3	17	20.7	3.28	2.13-5.06	<.001	2.08	1.34-3.23	**.001**
Acute renal failure	24	0.4	5	6.1	6.75	5.75-43.79	<.001	14.61	4.59-46.46	**<.001**
Ventilator >48 hours	36	0.5	5	6.1	11.93	4.80-29.64	<.001	6.48	2.84-14.80	**<.001**
Unplanned intubation	89	1.3	4	4.9	3.86	1.45-10.27	.007	2.36	0.87-6.40	.092
Septic shock	59	0.8	3	3.7	4.37	1.40-13.65	.011	2.28	0.72-7.27	.163
Sepsis	122	1.7	3	3.7	2.11	0.69-6.51	.192	1.53	0.48-4.83	.470
Return to the operating room	190	2.7	3	3.7	1.36	0.44-4.16	.593	1.15	0.38-3.51	.804
Coma >24 hours	14	0.2	2	2.4	12.28	2.83-53.15	.001	7.31	1.52-35.30	**.013**
Cardiac arrest requiring CPR	56	0.8	2	2.4	3.07	0.76-12.37	.115	2.16	0.49-9.52	.309
Myocardial infarction	133	1.9	2	2.4	1.29	0.33-5.13	.716	0.99	0.24-4.02	.988
Thromboembolic event (DVT/PE)	47	0.7	1	1.2	1.83	0.26-13.09	.548	1.70	0.20-14.33	.625
Any minor AE	1627	23.1	20	24.4	1.06	0.72-1.55	.780	1.10	0.75-1.63	.617
Urinary tract infection	487	6.9	4	4.9	0.71	0.27-1.84	.477	0.77	0.29-2.01	.590
Progressive renal insufficiency	27	0.4	1	1.2	3.18	0.44-23.15	.253	1.89	0.23-15.70	.558
Discharge destination[b]										
Facility	2374	79.8	24	72.7	0.82	0.51-1.31	.400	0.92	0.56-1.50	.732
Home	502	16.9	2	6.1	0.33	0.08-1.33	.119	0.47	0.11-2.09	.323
Unplanned readmission[b]	129	7.0	1	1.3	1.03	1.00-1.06	.046	0.10	0.88-1.06	.463

[a]Multivariate analysis controlled for all variables listed in Table 1; it did not include variables with zero incidence in either group (stroke/cerebrovascular accident, organ/space infection, superficial or deep surgical-site infection, wound dehiscence). All variables were entered as listed into model. Bolding indicates statistical significance at P < .05 level in multivariate analysis.
[b]Discharge and readmission data were available only for years 2011 and 2012 (2521 patients).
Abbreviations: AE, adverse event; CI, confidence interval; CPR, cardiopulmonary resuscitation; DVT, deep vein thrombosis; PE, pulmonary embolism; RR, relative risk; SAE, serious adverse event.

of patients with preoperative pneumonia at time of hip fracture repair, and the first to independently associate preoperative pneumonia with increased incidence of AEs, including death.

This study had its limitations. First, the ACS-NSQIP morbidity and mortality data, which are limited to the first 30 postoperative days, may be skewed because AEs that occurred after that interval are not captured. Second, coding of pneumonia in ACS-NSQIP does not convey specific information about the disease and its severity—infectious organism(s) responsible; acquisition setting (healthcare or community); treatment

given, including antibiotic(s) selection, steroid use, dosing, and duration; and measures of treatment efficacy—limiting interpretation of the difference in delay to surgery. We cannot say whether the longer interval in patients with pneumonia reflects medical optimization, or whether the delay itself or any interventions during that time positively or negatively affected outcomes. In addition, despite using a large national database, we obtained a relatively small sample of patients (82) who had pneumonia before surgical hip fracture repair.

Multivariate analysis controlling for baseline demographics and comorbidities revealed that

multiple SAEs were independently associated with preoperative pneumonia (overall SAE, RR = 1.79). Postoperative use of ventilator support for longer than 48 hours (RR = 6.48) and coma longer than 24 hours (RR = 7.31) are expected given the severity of pulmonary compromise in the study cohort.[28,29] Acute renal failure (RR = 14.61) can occur in both hip fracture patients and community-acquired pneumonia patients and may be a multifactorial complication of the pulmonary infection, of the anesthesia, or of the surgical intervention in this cohort.[30-32]

Unadjusted mortality in hip fracture takes months to a year to normalize to that of age-matched controls.[32-34] In our series, the unadjusted death rate in the pneumonia cohort (Figure) was transiently elevated during the first weeks after surgery but then drew nearer the rate in the non-diseased hip fracture cohort by the end of the first month. Early death in the pneumonia group likely was multifactorial, potentially influenced by the increased burden of comorbidities in the pneumonia group at baseline, and the longer delay to surgery,[35-38] as well as by the natural history of treated pneumonia in hospital patients, who, compared with age-matched hospitalized controls, also exhibit higher mortality during only the first 2 to 4 months of hospitalization for pneumonia.[39] We regret that
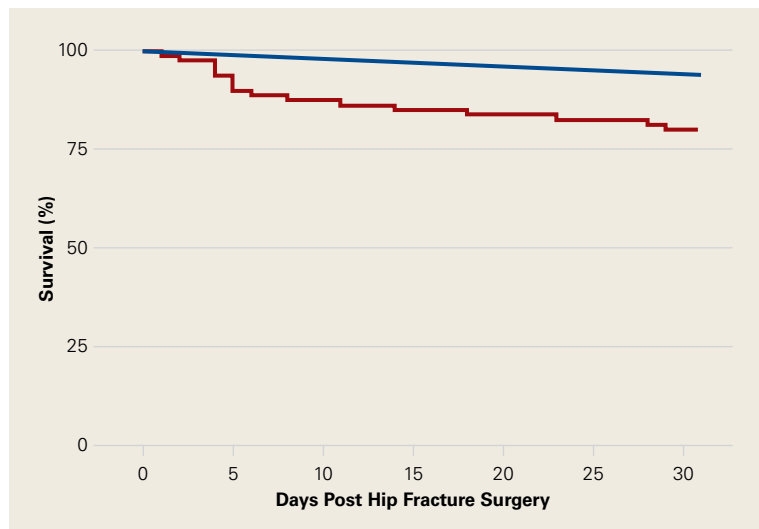
Figure. Kaplan-Meier survival analysis in geriatric hip fracture surgery patients with preoperative pneumonia (red line) and without preoperative pneumonia (blue line).

Table 3. Preoperative Predictors of Adverse Events in Geriatric Hip Fracture Surgery Patients With Preoperative Pneumonia[a]

Preoperative Predictor of AE	RR	95% CI	P
Any AE			
Male sex	1.33	0.89-2.00	.165
Uremia (blood urea nitrogen, >6.8 mmol/L)	1.29	0.90-1.85	.169
SAE			
History of cardiovascular disease[b]	2.25	0.92-5.50	.076
History of chronic obstructive pulmonary disease	1.49	0.86-2.57	.151
Death			
Male sex	2.35	0.99-5.56	.052
Functional dependence	3.20	0.97-10.57	.057
Body mass index, kg/m^2			**.014**
<18.5	4.67	1.76-12.40	
18.5-24.9	Reference		
25-29.9	0.35	0.07-1.77	
30-39.9	0.55	0.01-32.1	
≥40	1.34	0.51-3.51	
Preoperative dyspnea at rest	0.27	0.05-1.39	.118
History of chronic obstructive pulmonary disease	2.15	0.84-5.55	.112
History of smoking	5.61	0.95-33.41	.058

[a]Stepwise regression of covariates from Table 1 included at *P* < .2 significance level. Bolding indicates statistical significance at *P* < .05 level.
[b]Congestive heart failure, myocardial infarction, percutaneous coronary intervention, cardiac surgery, angina pectoris, medically treated hypertension, peripheral vascular disease, or resting claudication.
Abbreviations: AE, adverse event; CI, confidence interval; RR, relative risk; SAE, serious adverse event.

quality improvement strategies in the treatment of geriatric hip fracture surgery with pneumonia cannot be extrapolated from these results.

Similarly, the utility of BMI <18.5 kg/m^2 as an actionable preoperative finding cannot be assessed from these results. However, we propose that underweight geriatric hip fracture patients with pneumonia may benefit from more aggressive preoperative optimization that does not delay surgery. Higher acuity of postoperative care, including more intensive nursing care and early coordination of care with respiratory therapists and medical comanagement teams, may also be beneficial.

Anesthesia type did not differ between patients with and without preoperative pneumonia and was not associated with AEs in patients with preoperative pneumonia. Consistent with our findings, multiple studies have reported no significant differences in short-term outcomes of hip fracture repair between general and spinal anesthesia, though no other study has compared the benefits of general and spinal anesthesia for patients with preoperative pneumonia.[40-44] Although spinal anesthesia (relative to general anesthesia) has been reported to have benefits in hip and knee arthroplasty, these benefits appear not to translate to hip fracture repair.[45-50] The results of the present study suggest that general and spinal anesthesia may be equivalent in terms of risk for the geriatric hip fracture patient with preoperative pneumonia.[43,44]

Our attempt to evaluate the CURB-65 pneumonia severity score as a prognosticator of AEs was thwarted by the absence of required variables in the ACS-NSQIP dataset (confusion, uremia, dyspnea, and age were available; hypotension and blood pressure were not). In our analysis, we did include, individually, variables previously found to predict AEs in the medical pneumonia population (confusion, uremia, dyspnea at rest, anemia).[9-11,32] However, these clinical findings are nonspecific in hip fracture patients, who may become anemic, confused, dyspneic, or uremic from a multitude of factors related to their injury and unrelated to pneumonia, including but not limited to hemorrhage, muscle damage, renal injury, and pulmonary embolism. It is not surprising that confusion, uremia, dyspnea at rest, and anemia were not individually predictive of AEs or death within 30 days after surgery in the cohort of geriatric hip fracture patients with pneumonia.

There is no literature that argues for or against delaying hip fracture surgery in geriatric hip fracture patients with pneumonia. The surgical delay observed in this population is ostensibly related to medical optimization of the pneumonia and/or underlying comorbidities. However, we did not find a morbidity or mortality detriment or benefit in delaying surgery by 1 to 4 days in this population. Delay of surgery is a poor covariate, given extensive confounding by medical management and preoperative optimizing of comorbid conditions (reflected in our independent variable and covariates) as well as institutional and surgeon variations in policy and behavior and other unaccounted influences. Although some authors have found no difference in mortality or major AEs between hip fracture patients who had a surgical delay and those who did not,[31,51-53] other series and meta-analyses have suggested a mortality detriment in a surgical delay of more than 2 days[36,54] or 4 days[55] from admission. Given our data, we cannot recommend against immediate hip fracture repair in the subpopulation of geriatric hip fracture patients with pneumonia.

Our study findings suggest that preoperative pneumonia is a rare independent risk factor for AEs after hip fracture surgery in geriatric patients. Underweight BMI is predictive of death in geriatric hip fracture surgery patients who present with pneumonia, whereas early surgical repair appears not to be associated with adverse outcomes. Further investigation is warranted to determine if such patients benefit from specific preoperative and postoperative strategies for optimizing medical and surgical care based on these findings.

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References

1. Sexson SB, Lehner JT. Factors affecting hip fracture mortality. *J Orthop Trauma.* 1987;1(4):298-305.
2. Mullen JO, Mullen NL. Hip fracture mortality: a prospective, multifactorial study to predict and minimize death risk. *Clin Orthop Relat Res.* 1992;(280):214-222.
3. Kenzora JE, McCarthy RE, Lowell JD, Sledge CB. Hip fracture mortality. Relation to age, treatment, preoperative illness, time of surgery, and complications. *Clin Orthop Relat Res.* 1984;(186):45-56.
4. Auron-Gomez M, Michota F. Medical management of hip fracture. *Clin Geriatr Med.* 2008;24(4):701-719.
5. Bohl DD, Basques BA, Golinvaux NS, Baumgaertner MR, Grauer JN. Nationwide Inpatient Sample and National Surgical Quality Improvement Program give different results in hip fracture studies. *Clin Orthop Relat Res.* 2014;472(6):1672-1680.
6. Lim WS, van der Eerden MM, Laing R, et al. Defining community acquired pneumonia severity on presentation to hospital: an international derivation and validation study. *Thorax.* 2003;58(5):377-382.
7. Myint PK, Kamath AV, Vowler SL, Maisey DN, Harrison BDW. The CURB (confusion, urea, respiratory rate and blood pressure) criteria in community-acquired pneumonia (CAP) in hospitalised elderly patients aged 65 years and over: a prospective observational cohort study. *Age Ageing.* 2005;34(1):75-77.
8. Wilkinson M, Woodhead MA. Guidelines for community-acquired pneumonia in the ICU. *Curr Opin Crit Care.* 2004;10(1):59-64.
9. Buising K, Thursky K, Black J, et al. A prospective comparison of severity scores for identifying patients with severe community acquired pneumonia: reconsidering what is meant by severe pneumonia. *Thorax.* 2006;61(5):419-424.
10. Ewig S, De Roux A, Bauer T, et al. Validation of predictive rules and indices of severity for community acquired pneumonia. *Thorax.* 2004;59(5):421-427.
11. Yandiola PP, Capelastegui A, Quintana J, et al. Prospective comparison of severity scores for predicting clinically relevant outcomes for patients hospitalized with community-acquired pneumonia. *Chest.* 2009;135(6):1572-1579.
12. Lim WS, Lewis S, Macfarlane JT. Severity prediction rules in community acquired pneumonia: a validation study. *Thorax.* 2000;55(3):219-223.
13. Bauer TT, Ewig S, Marre R, Suttorp N, Welte T; CAPNETZ Study Group. CRB-65 predicts death from community-acquired pneumonia. *J Intern Med.* 2006;260(1):93-101.
14. Khuri SF. The NSQIP: a new frontier in surgery. *Surgery.* 2005;138(5):837-843.
15. American College of Surgeons. *User Guide for the 2012 ACS NSQIP Participant Use Data File: American College of Surgeons National Surgical Quality Improvement Program.* https://www.facs.org/~/media/files/quality%20programs/nsqip/ug12.ashx. Published October 2013. Accessed October 8, 2014.
16. Ingraham AM, Richards KE, Hall BL, Ko CY. Quality improvement in surgery: the American College of Surgeons National Surgical Quality Improvement Program approach. *Adv Surg.* 2010;44(1):251-267.
17. Schilling PL, Hallstrom BR, Birkmeyer JD, Carpenter JE. Prioritizing perioperative quality improvement in orthopaedic surgery. *J Bone Joint Surg Am.* 2010;92(9):1884-1889.
18. Radcliff TA, Henderson WG, Stoner TJ, Khuri SF, Dohm M, Hutt E. Patient risk factors, operative care, and outcomes among older community-dwelling male veterans with hip fracture. *J Bone Joint Surg Am.* 2008;90(1):34-42.
19. Katzan I, Cebul R, Husak S, Dawson N, Baker D. The effect of pneumonia on mortality among patients hospitalized for acute stroke. *Neurology.* 2003;60(4):620-625.
20. Fisher MA, Matthei JD, Obirieze A, et al. Open reduction internal fixation versus hemiarthroplasty versus total hip arthroplasty in the elderly: a review of the National Surgical Quality Improvement Program database. *J Surg Res.* 2013;181(2):193-198.
21. Pugely AJ, Martin CT, Gao Y, Klocke NF, Callaghan JJ, Marsh JL. A risk calculator for short-term morbidity and mortality after hip fracture surgery. *J Orthop Trauma.* 2014;28(2):63-69.
22. Fine MJ, Smith MA, Carson CA, et al. Prognosis and outcomes of patients with community-acquired pneumonia: a meta-analysis. *JAMA.* 1996;275(2):134-141.
23. Donegan DJ, Gay AN, Baldwin K, Morales EE, Esterhai JL Jr, Mehta S. Use of medical comorbidities to predict complications after hip fracture surgery in the elderly. *J Bone Joint Surg Am.* 2010;92(4):807-813.
24. Zou G. A modified poisson regression approach to prospective studies with binary data. *Am J Epidemiol.* 2004:159(7):702-706.
25. Murphy SL, Xu J, Kochanek KD. Deaths: final data for 2010. *Natl Vital Stat Rep.* 20138;61(4):1-117.
26. Bhattacharyya T, Iorio R, Healy WL. Rate of and risk factors for acute inpatient mortality after orthopaedic surgery. *J Bone Joint Surg Am.* 2002;84(4):562-572.
27. Myers AH, Robinson EG, Van Natta ML, Michelson JD, Collins K, Baker SP. Hip fractures among the elderly: factors associated with in-hospital mortality. *Am J Epidemiol.* 1991;134(10):1128-1137.
28. Mandell LA, Wunderink RG, Anzueto A, et al; Infectious Diseases Society of America; American Thoracic Society. Infectious Diseases Society of America/American Thoracic Society consensus guidelines on the management of community-acquired pneumonia in adults. *Clin Infect Dis.* 2007;44(suppl 2):S27-S72.
29. Leroy O, Santre C, Beuscart C, et al. A five-year study of severe community-acquired pneumonia with emphasis on prognosis in patients admitted to an intensive care unit. *Intensive Care Med.* 1995;21(1):24-31.
30. Urwin S, Parker M, Griffiths R. General versus regional anaesthesia for hip fracture surgery: a meta-analysis of randomized trials. *Br J Anaesth.* 2000;84(4):450-455.
31. Orosz GM, Magaziner J, Hannan EL, et al. Association of timing of surgery for hip fracture and patient outcomes. *JAMA.* 2004;291(14):1738-1743.
32. Niederman MS, Mandell LA, Anzueto A, et al; American Thoracic Society. Guidelines for the management of adults with community-acquired pneumonia: diagnosis, assessment of severity, antimicrobial therapy, and prevention. *Am J Respir Crit Care Med.* 2001;163(7):1730-1754.
33. Koval KJ, Skovron ML, Aharonoff GB, Zuckerman JD. Predictors of functional recovery after hip fracture in the elderly. *Clin Orthop Relat Res.* 1998;(348):22-28.
34. Doruk H, Mas MR, Yildiz C, Sonmez A, Kýrdemir V. The effect of the timing of hip fracture surgery on the activity of daily living and mortality in elderly. *Arch Gerontol Geriatr.* 2004;39(2):179-185.
35. George GH, Patel S. Secondary prevention of hip fracture. *Rheumatology.* 2000;39(4):346-349.
36. Bottle A, Aylin P. Mortality associated with delay in operation after hip fracture: observational study. *BMJ.* 2006;332(7547):947-951.
37. Grimes JP, Gregory PM, Noveck H, Butler MS, Carson JL. The effects of time-to-surgery on mortality and morbidity in patients following hip fracture. *Am J Med.* 2002;112(9):702-709.
38. Simunovic N, Devereaux P, Sprague S, et al. Effect of early surgery after hip fracture on mortality and complications: systematic review and meta-analysis. *CMAJ.* 2010;182(15):1609-1616.
39. Kaplan V, Clermont G, Griffin MF, et al. Pneumonia: still the old man's friend? *Arch Intern Med.* 2003;163(3):317-323.

40. Parker MJ, Handoll HH, Griffiths R. Anaesthesia for hip fracture surgery in adults. *Cochrane Database Syst Rev.* 2004;(4):CD000521.

41. Chakladar A, White SM. Cost estimates of spinal versus general anaesthesia for fractured neck of femur surgery. *Anaesthesia.* 2010;65(8):810-814.

42. White SM, Moppett IK, Griffiths R. Outcome by mode of anaesthesia for hip fracture surgery. An observational audit of 65 535 patients in a national dataset. *Anaesthesia.* 2014;69(3):224-230.

43. Gilbert TB, Hawkes WG, Hebel JR, et al. Spinal anesthesia versus general anesthesia for hip fracture repair: a longitudinal observation of 741 elderly patients during 2-year follow-up. *Am J Orthop.* 2000;29(1):25-35.

44. O'Hara DA, Duff A, Berlin JA, et al. The effect of anesthetic technique on postoperative outcomes in hip fracture repair. *Anesthesiology.* 2000;92(4):947-957.

45. Hole A, Terjesen T, Breivik H. Epidural versus general anaesthesia for total hip arthroplasty in elderly patients. *Acta Anaesthesiol Scand.* 1980;24(4):279-287.

46. Rashiq S, Finegan BA. The effect of spinal anesthesia on blood transfusion rate in total joint arthroplasty. *Can J Surg.* 2006;49(6):391-396.

47. Chang CC, Lin HC, Lin HW, Lin HC. Anesthetic management and surgical site infections in total hip or knee replacement: a population-based study. *Anesthesiology.* 2010;113(2):279-284.

48. Mauermann WJ, Shilling AM, Zuo Z. A comparison of neuraxial block versus general anesthesia for elective total hip replace-ment: a meta-analysis. *Anesth Analg.* 2006;103(4):1018-1025.

49. Hu S, Zhang ZY, Hua YQ, Li J, Cai ZD. A comparison of regional and general anaesthesia for total replacement of the hip or knee: a meta-analysis. *J Bone Joint Surg Br.* 2009;91(7):935-942.

50. Pugely AJ, Martin CT, Gao Y, Mendoza-Lattes S, Callaghan JJ. Differences in short-term complications between spinal and general anesthesia for primary total knee arthroplasty. *J Bone Joint Surg Am.* 2013;95(3):193-199.

51. Khan SK, Kalra S, Khanna A, Thiruvengada MM, Parker MJ. Timing of surgery for hip fractures: a systematic review of 52 published studies involving 291,413 patients. *Injury.* 2009;40(7):692-697.

52. Majumdar SR, Beaupre LA, Johnston DW, Dick DA, Cinats JG, Jiang HX. Lack of association between mortality and timing of surgical fixation in elderly patients with hip fracture: results of a retrospective population-based cohort study. *Med Care.* 2006;44(6):552-559.

53. Moran CG, Wenn RT, Sikand M, Taylor AM. Early mortality after hip fracture: is delay before surgery important? *J Bone Joint Surg Am.* 2005;87(3):483-489.

54. Shiga T, Wajima Zi, Ohe Y. Is operative delay associated with increased mortality of hip fracture patients? Systematic review, meta-analysis, and meta-regression. *Can J Anesth.* 2008;55(3):146-154.

55. Streubel P, Ricci W, Wong A, Gardner M. Mortality after distal femur fractures in elderly patients. *Clin Orthop Relat Res.* 2011;469(4):1188-1196.

This paper will be judged for the Resident Writer's Award.